

Digital Content (Aplia) – Defining Characteristics and Pedagogical Best Practices

Aplia content often uses step-by-step questions that break a complex mechanical or reasoning process down into its component steps so that each step is graded and interactive. Step-by-step questions are important for a number of reasons:

- Breaking a complex process down into gradable component steps helps to ensure that you are holding students accountable not only for the correct answer to the overall process but also for their ability to reason to the correct answer in the proper way.
- Gradable elements for each step allow students to more easily locate places where they need additional remediation or help.
- Turning complex processes into gradable steps is generally more effective pedagogically than just asking about the correct answer and explaining the steps in the explanation. This is because many students will not read the explanations but they will complete required, graded questions.

The following screenshots show some effective examples of step-by-step questions:

Step-by-step, example 1:

Suppose you are given one blue urn and three green urns, in a dark room so that you cannot tell the difference between the urns. The blue urn contains seven red balls and three yellow balls. Each green urn contains three red balls and seven yellow balls. You draw a ball at random from one of the urns.

Let event A_1 be drawing a ball from a blue urn. What is the probability of event A_1 ?

$P(A_1) =$

Let event A_2 be drawing a ball from a green urn. What is the probability of event A_2 ?

$P(A_2) =$

Let event B be drawing a red ball. Assuming the urn is blue, what is the probability of drawing a red ball from the blue urn?

$P(B \text{ given } A_1) =$

Let event B be drawing a red ball. Assuming the urn is green, what is the probability of drawing a red ball from the green urn?

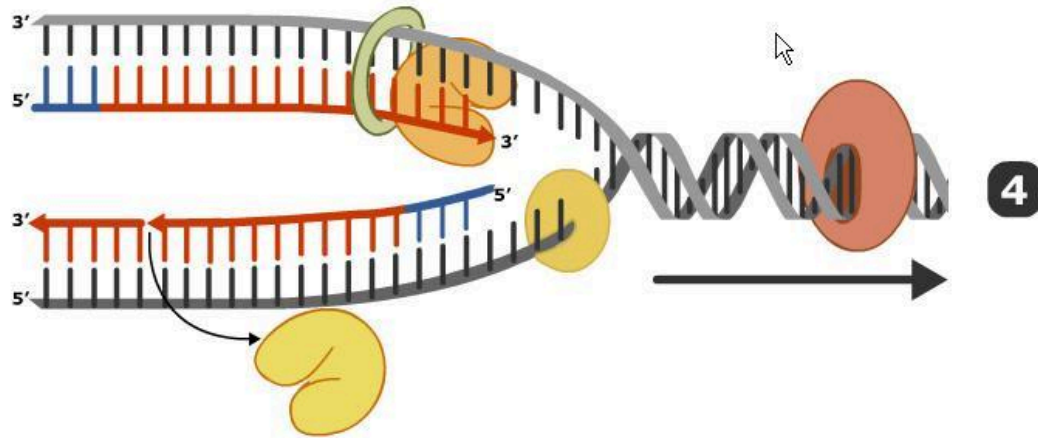
$P(B \text{ given } A_2) =$

Assuming you draw a red ball from one of the urns, what is the (decimal) probability that the urn was blue according to Bayes's Theorem?

$P(A_1 \text{ given } B) =$

Step-by-step, example 2:

Click on the blue image links below to reveal the steps of DNA replication in *E. coli*. As you reveal each step, describe it by filling in the blanks.



- [Step 1]** DNA helicase _____ along the DNA helix. Once the DNA is unwound, _____ synthesize RNA _____ to begin synthesis of the _____ template _____ strands.
- [Step 2]** Primers are used as starting points to which _____ are added by the enzyme _____.
- [Step 3]** As more DNA is unwound, _____ synthesis requires the synthesis of a new primer. The discontinuous sections of DNA synthesized from the new primers are called _____.
- [Step 4]** Once removed, primers are replaced with DNA by a different DNA polymerase. Breaks between the newly synthesized segments, called _____, remain.
- [Step 5]** The breaks are sealed by _____.
- [Step 6]** DNA replication continues along the circular bacterial chromosome until the two replication forks meet up. Unlike *E. coli*, eukaryotic cells have linear chromosomes that contain short repeating segments of noncoding DNA at their ends called _____.

Another defining characteristic of Aplia content is the presence of questions that ask about the reason an answer is correct. Asking the student to explain why an answer is correct ensures genuine comprehension of the material and minimizes the extent to which they can guess their way through a problem set.

- Keywords include words such as “therefore,” “because,” “so,” “why,” and so on.
- Strive to integrate reasoning questions with other questions in a smooth, readable way.
- One approach is to use multiple gradable elements to make students reason their way to a correct answer. Another approach is to make students explain why a prior or subsequent answer is correct.

The following screenshots show effective examples of reasoning questions.

Reasoning questions, example 1:

There are two apples on the table, and there are two oranges on the table.
Therefore, it follows that there are at least four fruits on the table.

In the above argument, the conclusion follows by probability, so the argument is deductive.

Reasoning questions, example 2:

Argument A

Because Mexico is north of Brazil, and Brazil is north of Antarctica, it follows that Mexico is north of Antarctica.

Argument A is _____ and
_____ all true premises.
Therefore, Argument A is _____.

Argument B

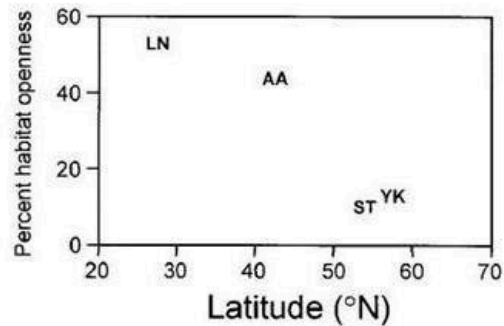
Since Iowa is west of California, and California is west of New York, it follows that Iowa is west of New York.

Argument B is valid and
_____ does have _____ all true premises.
Therefore, Argument B is _____.

Reasoning questions, example 3:

In 2000, Dr. Darren E. Irwin traveled all over Asia and collected data about local green warbler populations. The symbols on the map above refer to locations he visited. These locations are represented on the graphs below by a two-letter designation (for example, MN, which stands for Mongolia). At each site, he quantified characteristics of the local greenish warbler song and properties of the local environment that would have a strong influence on bird song. For example, the density of the forest has direct effects on the acoustics of bird song, or how it is heard.

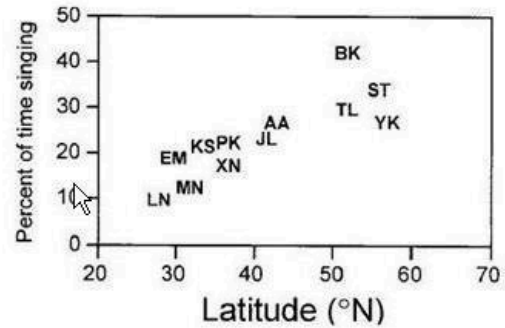
How the environment varies with latitude



As he moved farther north (increase in latitude), what observations did he make about how the environment changed?

- ☐ The habitat becomes less open.
- ☐ The habitat becomes more open.

How bird song behavior varies with latitude



As he moved farther north (increase in latitude), what observations did he make about how song behavior changed?

- ☐ The warblers spend more time singing.
- ☐ The warblers spend less time singing.

Bird song appears _____ to change gradually with _____ increases in latitude.

From the observational data presented, the greenish warbler appears to exhibit _____ genetic drift _____ in the amount of time it spends singing, perhaps due to changes in the openness of its habitat.

This screenshot is an example of a **less-effective** reasoning question because it does not hold students accountable for the reasoning process used to obtain the correct answer:

Argument A

A given shape has eight sides of equal length.
Therefore, the figure is an octagon.

Argument A is: Valid

Argument B

There are 33 states in the United States of America, and every state has 3 senators. It follows from this that there are 99 United States senators.

Argument B is: Valid

A defining style characteristic of Aplia questions is the incorporation of narrative-style questions that incorporate reasoning questions into a seamless, readable narrative. This narrative helps to reinforce the thought process that you want a student to go through.

- Use multiple selection lists within the same sentence or paragraph for a readable text that is gradable and interactive.
- To construct this style of question effectively, think of the explanation you would write about how to obtain a correct answer to some overall question (or consider what process you would take a student through if you were teaching the material). Then locate the crucial parts of this explanation (for example, key distinctions, definitions, determining whether something is true or false, or whether something does or does not have a certain property). Make it a goal to have a gradable selection list corresponding to each important point in the narrative you would tell if you were teaching the material.

The following screenshots show examples of questions incorporating reasoning questions in a narrative style:

Narrative questions, example 1:

Read the scenario below about Kevin and a dilemma he is currently facing. Then complete the steps of the problem-solving method as applied to Kevin's specific situation.

Kevin is a single father of one child. He is also attending a college in Colorado as a full-time student. Although he is making ends meet, paying for and finding childcare can be difficult, especially since he is also paying school tuition and needs to make time to study. Recently, Kevin's parents offered to help out with childcare if Kevin moves back to his hometown in Oregon. Kevin would ordinarily not even consider moving because he values his education and loves his current school, but there is an equally priced college in his hometown, and he knows having reliable childcare is essential to achieving his goals. He cannot decide whether or not to move and must make a decision before the school year begins.

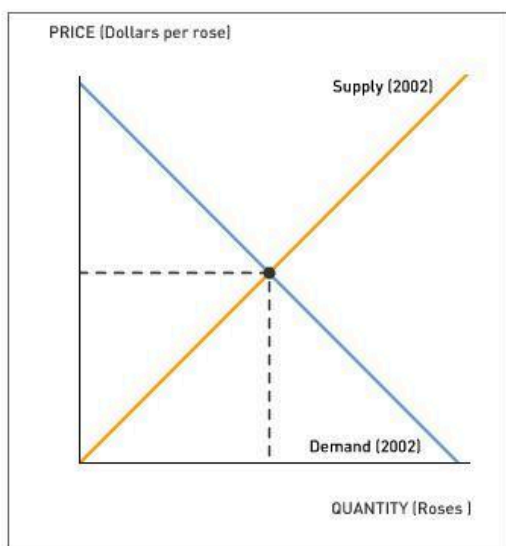
- Step 1:** Kevin's goal is to make a choice between _____ before the school year begins.
- Step 2:** Kevin must _____, because those are the boundaries of his situation.
Kevin must pick between _____ and _____.
- Step 3:** The _____ advantage _____ of moving is that Kevin will have to leave his friends and the school he loves.
The _____ disadvantage _____ of moving is that Kevin's child will have a better support network.
- Step 4:** Although Kevin likes his current school, it is more important that Kevin has stable and affordable childcare for his child while he gets his degree, so Kevin ought to _____.
- Step 5:** Kevin will continue to _____ his choice as time passes.

Narrative questions, example 2:

The graph below shows the market for roses in 2002. Between 2002 and 2003, the equilibrium price of roses remained constant, but the equilibrium quantity of roses decreased. From this, we can conclude that between 2002 and 2003, the supply of roses increased and the demand for roses decreased.

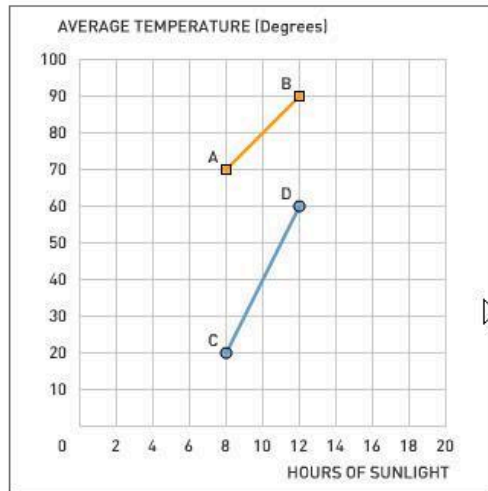
Adjust the graph to illustrate your answer by showing the positions of the supply and demand curves in 2003.

Tool tip: Click and drag one or both of the curves. Curves will snap into position, so if you try to move the curve and it snaps back to its original position, just try again and drag it a little farther.



Narrative questions, example 3:

Because different cities are located in different climates, the relationship between hours of sunlight and average temperature may vary. The following graph shows the relationship between average temperature and hours of sunlight in two cities located in two very different climates:



The slope of the orange line between points A and B is _____ and the slope of the blue line between points C and D is _____.

The mathematical slope of the steeper line is _____ the slope of the less steep line.

Aplia questions serve the dual purpose of teaching and assessment. Assessment alone is less effective pedagogically than teaching and assessment combined.

- Learning is a process. To teach effectively, you must take students through the thought process that will lead to genuine learning and understanding.
- The fact that Aplia's authoring and rendering environments allow for more than one gradable element on a page means that you can use those elements to take students through a similar process that you would use to teach the material, but in a gradable way.
- Consider how you teach your subject matter in class. What examples do you use to illustrate a concept? What reasoning process do you walk your students through to analyze those examples? How do you make key distinctions and definitions more intuitive and comprehensible? What process do you use to take your students from mere memorization to genuine critical thinking and application?
- Using questions to walk students through a pedagogically sound learning process is not handholding. You are providing the scaffolding for them to go through a process-based learning process and holding them accountable for every step in that process.
- It can be difficult for a content developer to transition from more traditional ways of writing questions under an assessment-based model (for example, exam questions, end-of-chapter questions, and simplistic multiple choice questions) to a question model immersing students within the material and within a process-based learning environment that simultaneously teaches and assesses.
- In your questions, you should strive to mirror the structure of how you would teach or tutor the material to your students.